

## CLINICAL REPORT

# Use of an attachment system with angulated abutments and polyetheretherketone inserts to retain a maxillary overdenture: A clinical report

Qin Yue, DDS,<sup>a</sup> Burak Yilmaz, DDS, PhD,<sup>b</sup> Samir Abou-Ayash, Dr med dent,<sup>c</sup> Patrick Zimmermann, CDT,<sup>d</sup> Urs Brägger, Dr med dent habil,<sup>e</sup> and Martin Schimmel, Dr med dent habil, MAS<sup>f,g</sup>

Implant-retained overdentures are a commonly used prosthetic treatment option for completely edentulous patients.<sup>1</sup> Various types of attachments are used,<sup>2</sup> including bars or studs and depending on the arch and interocclusal space.<sup>3</sup> Bars cannot be used if the interocclusal space is limited, but stud attachments may be suitable as they require less space for the prosthetic components.<sup>3</sup> However, although prefabricated stud attachments such as the LOCATOR (Zest Dental Solutions) allow for angle correction to a certain degree, they cannot be used with angulated abutments, and loss of retention may be a problem.<sup>4</sup>

A recently introduced attachment system (Novaloc; Straumann AG) enables angulation correction for implants with angulated abutments and, therefore, can decrease the wear of inserts in the housings of this attachment system. In addition, this system has polyetheretherketone (PEEK) rather than nylon inserts, which may also decrease the wear rate.<sup>5</sup> Custom fabrication of angled overdenture abutments has been reported,<sup>6</sup> but custom fabrication either by casting or by using CAD-CAM technologies is more time consuming

## ABSTRACT

This clinical report describes the rehabilitation of a maxillary edentulous arch with a current overdenture attachment system with angulated prefabricated abutments and polyetheretherketone (PEEK) inserts. Prefabricated angulated abutments were used on previously and recently placed diverging implants, which enabled a common path of insertion for the overdenture to be established during fabrication. (J Prosthet Dent 2019;■:■-■)

and labor intensive than using prefabricated abutments.<sup>6</sup> Having the option of an angulated prefabricated abutment can help establish a common path of insertion with divergent implants in a time- and cost-efficient manner. The authors are unaware of reports describing the use of this current attachment system with angulated abutments and polyetheretherketone inserts.

This clinical report describes the rehabilitation of a completely edentulous maxilla with an overdenture by using a current attachment system. The use of angulated abutments enabled the correction of the path of insertion of the denture, which resulted in a favorable clinical outcome.

## CLINICAL REPORT

A 39-year-old man presented at the Department of Reconstructive Dentistry and Gerodontology, School of Dental Medicine, University of Bern. The patient had

<sup>a</sup>Lecturer, Stomatology Center, China-Japan Friendship Hospital, Beijing, PR China; and ITI Scholar for 2017, Department of Reconstructive Dentistry and Gerodontology, School of Dental Medicine, University of Bern, Bern, Switzerland.

<sup>b</sup>Professor, Division of Restorative and Prosthetic Dentistry, College of Dentistry, The Ohio State University, Columbus, Ohio.

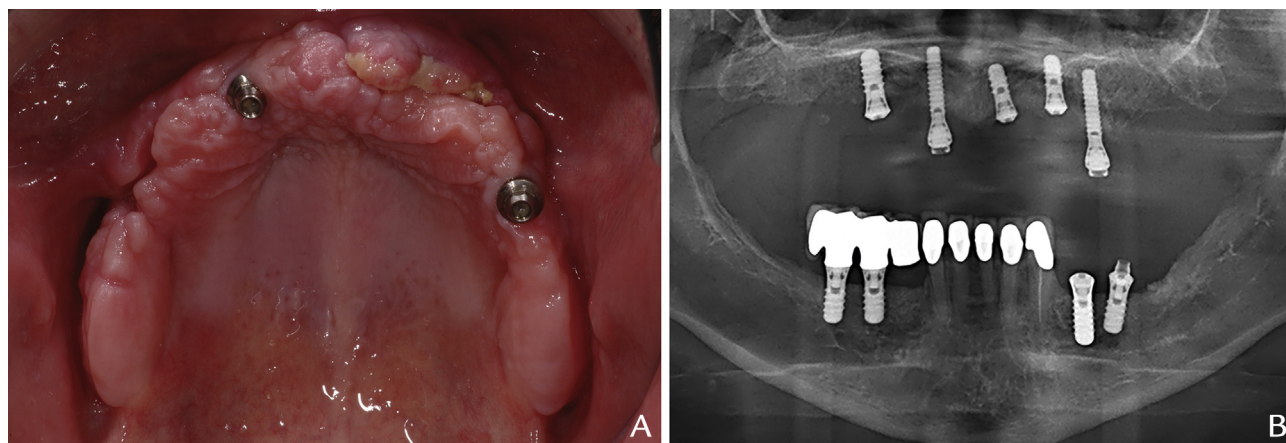
<sup>c</sup>Senior Lecturer, Section for Digital Implant and Reconstructive Dentistry [DIRecD], Department of Reconstructive Dentistry and Gerodontology, School of Dental Medicine, University of Bern, Bern, Switzerland.

<sup>d</sup>Master Dental Technician (Advanced Federal Diploma of Higher Education), Zahnmanufaktur, Bern, Switzerland.

<sup>e</sup>Professor, Department of Reconstructive Dentistry and Gerodontology, School of Dental Medicine, University of Bern, Bern, Switzerland.

<sup>f</sup>Professor, Division of Gerodontology, School of Dental Medicine, University of Bern, Bern, Switzerland.

<sup>g</sup>Privat Docent, Division of Gerodontology and Removable Prosthodontics, University of Geneva, Geneva, Switzerland.



**Figure 1.** A, Healing of submerged new implants placed after existing implants were removed. B, Panoramic radiograph after placement of new implants.

been diagnosed with generalized amelogenesis imperfecta when he was 19 years old. Except for the mandibular incisors and left canine, all teeth had been removed concomitant with an osteotomy as the teeth were unerupted and ankylosed, and a maxillary complete denture had been provided. Three years after the extractions, the patient was seeking stable reconstructions in both arches. To correct the atrophic maxilla and thereby rectify its relationship to the mandible, the patient had undergone a LeFort I osteotomy and maxillary anterior displacement with bone grafting. He had been rehabilitated with a maxillary bar-retained overdenture on 4 implants at the maxillary right second premolar, right lateral, left lateral, and left second premolar sites. He had received screw-retained splinted implant crowns in the posterior mandible. The patient then developed peri-implantitis on several implants when he was 34 years old. After ongoing peri-implantitis treatment, 5 of the implants (2 maxillary and 3 mandibular) were removed, and the patient continued using his maxillary overdenture after modifications had been made. His chief complaints were the instability of the prosthesis and his unattractive facial profile with the prosthesis.

The patient was a nonsmoker, presented in good general health, and was not taking any prescription medication. The patient's transitional overdenture was retained with LOCATOR (Zest Dental Solutions) abutments on implants at the maxillary right central incisor and left second premolar sites. In the mandible, 2 implants and the left implant-supported fixed partial denture (FPD) were lost. The metal-ceramic crowns on the mandibular natural anterior teeth remained intact. The periodontal condition was healthy, with no signs of inflammation, although the platforms and polished necks of the remaining implants were exposed. The patient's expectations were to be able to participate in social activities and to masticate medium-to-hard foods.

From the surgical aspect, the patient presented with limited bone volume in both height and width. Resulting from the displacement of the anterior maxilla and the bone resorption after removal of the failed implants in the anterior region, the distance between the crest and nasal floor was approximately 8 mm; the width of the crest was sufficient for implant placement. In the maxillary premolar region, the bone height was 10 mm with narrow alveolar crests, which in some areas were only 4 to 5 mm. At the mandibular left first premolar site, the bone width and height were sufficient for implant placement. The option to use the existing bone as much as possible instead of less predictable grafting seemed to be a prudent option.<sup>7</sup>

Considering the remaining bone, prosthetic evaluations, and the patient's needs, the treatment plan was to place 3 new implants at the selected sites in the maxilla that did not require additional bone augmentation procedures for standard implant placement: the maxillary right second premolar, maxillary left central incisor, and maxillary left first premolar sites, and one new implant in the mandible at the left first premolar site. As an overdenture retained by 2 existing implants had already been successfully used, a U-shaped overdenture with 5 nonsplinted implants in the maxillary arch was proposed. The proposed overdenture retaining components comprised 5 nonsplinted attachments (Novaloc), including angled abutments (Novaloc angled), supported by 3 new and 2 previously placed tissue-level implants (Straumann). A treatment sequence was planned. The patient was first to wear the existing interim overdenture (LOCATOR retained) during a healing phase of 3 months or more after removal of the failed implants. After healing, implants were placed in the maxillary right second premolar, left central incisor, and left first premolar positions, and guided bone regeneration was performed at the maxillary right second premolar and left first premolar regions. After a healing phase of 6



**Figure 2.** A, Clinical evaluation abutments in place. B, Definitive abutments in place. C, Impression copings placed on abutments. D, Occlusal view of impression copings showing corrected divergence of implants.

months or more, an implant was placed at the mandibular left first premolar site, and second-stage surgery was performed on the submerged implants. After uncovering implants, the fabrication of a maxillary overdenture and an FPD for the left posterior mandible was planned. Taking all information into consideration, the current situation was classified as complex in the normative SAC classification, with medium additional complexity and risk based on modifiers. The patient consented to the treatment plan after discussing alternatives and options.

After the healing time following implant removal, implant placement and augmentation procedures were performed. The implants (Straumann, SP, 4.1 mm, RN, SLActive, TiZr) were placed at the maxillary right second premolar (10 mm), left central incisor (8 mm), and mandibular left first premolar (8 mm) sites. Implant placement at the mandibular left first premolar was also performed (Straumann, SP, 4.1 mm, RN, 10 mm, SLActive, TiZr). All implants were subjected to submerged healing. After 6 months of healing, all implants were uncovered, healing abutments (Straumann) were inserted, and the patient visited the prosthodontist for the reconstructive phase 1 month after the second-stage surgery (Fig. 1).

The abutments (Novaloc) were chosen using single-use clinical evaluation abutments (Fig. 2). The height of the abutments was chosen to make sure that the housing of the matrices would not touch the peri-implant mucosa to avoid trauma. Therefore, the shoulders of the abutments were selected to be placed at least 1 mm above the mucosa. The second consideration for the height selection was the path of insertion of the overdenture. To avoid interferences, the top platform of the abutments in 1 arch formed an even plane, which was parallel to the occlusal plane.<sup>8</sup>

Five abutments were chosen with specified heights to compensate for vertical discrepancies in the maxilla (2 mm angled for right second premolar, 2 mm straight for right lateral, 3 mm angled for left lateral, 6 mm angled for left first premolar, and 2 mm straight for left second premolar). Fifteen degree-angled abutments (Novaloc angled) were selected for the maxillary right second premolar, right lateral, and left second premolar to compensate for the diverging implant axes respective to each other (Fig. 2).

All abutments (Novaloc) were screwed in and tightened to 35 Ncm; the interim overdenture was relieved in the areas of the abutments. Custom trays (Fino





**Figure 3.** Wax evaluation of maxillary overdenture and mandibular fixed partial denture.

Löffelplatten; FINO GmbH) were made on casts poured from preliminary irreversible hydrocolloid impressions. Impression elastics (Novaloc) were snapped on the abutments. An abutment-level impression was made by using viscoelastic vinylsiloxanether (Identium; Kettenbach GmbH). Abutment analogs (Novaloc) were placed in the impression, and the stone (Dental Klasse 4 Primus; Klasse 4 Dental GmbH) was poured.

For the FPD between the mandibular left first premolar and first molar, an open-tray impression was made with a vinylsiloxanether (Identium; Kettenbach GmbH). On the definitive cast, the record base and occlusal wax rim was fabricated by using previously incorporated overdenture housings to ensure maximum stability of the record base. The anterior teeth were selected (SR Vivodent SPE; Ivoclar Vivadent AG) by using the Candulor Alameter and Candulor Papillameter to determine the length of the maxillary lip and width of the anterior teeth. For the posterior teeth, SR Orthotyp S PE (Ivoclar Vivadent AG) was chosen. A clinical evaluation for the tooth arrangement was performed (Fig. 3), occlusion, vertical dimension at centric relation, and speech were evaluated, and the patient consented to the processing of the overdenture.

A metal framework was cast (Remanium GM 380; Dentaaurum), and titanium housings (Novaloc) with mounting inserts (white) were fixed (AGC Cem Automix; Ivoclar Vivadent AG) (Fig. 4). The denture base was processed (IvoBase; Ivoclar Vivadent AG). For the mandibular arch, a screw-retained zirconia (Ceramill Zolid; Amann Girrbach) FPD on a titanium base (Variobase; Straumann) with feldspathic white and pink gingiva porcelain (Ceramotion ZR; Dentaaurum) was fabricated. At the delivery appointment, the maxillary angled abutments were tightened to 35 Ncm, and the overdenture was placed. The mandibular FPD abutment screws were tightened to 35 Ncm. Centric relation was checked, occlusal adjustments were performed, and the



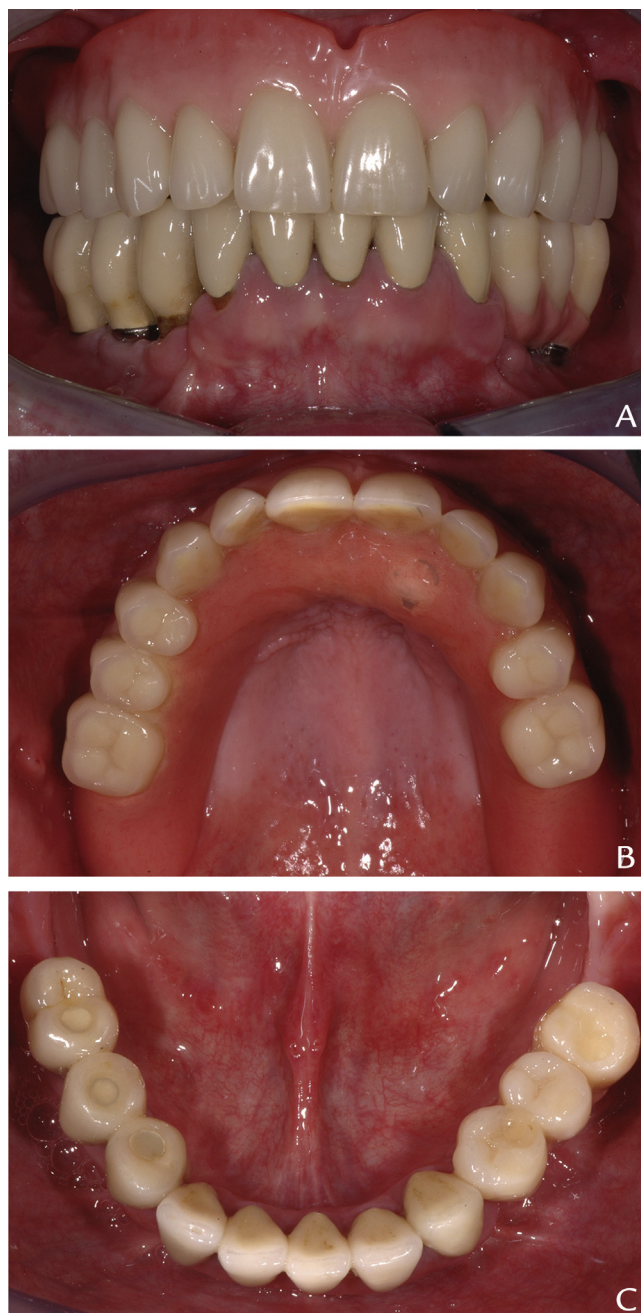
**Figure 4.** PEEK inserts in housings in processed overdenture. PEEK, polyetheretherketone.

adjusted surfaces on the acrylic resin teeth were polished with a pumice and water mixture. The screw channels were sealed with polytetrafluoroethene (PTFE) and a composite resin (Tetric Evoceram; Ivoclar Vivadent AG). Postinsertion recommendations were given, and the patient was placed on recall every 6 months. The patient was satisfied with the outcome, reporting favorable mastication and a natural appearance that fulfilled his main expectations. Although the patient had experienced many surgical treatments because of congenital disease and implant failures, he remained optimistic and could smile with confidence without being concerned about his prosthesis.

## DISCUSSION

From a prosthodontic perspective, several considerations led to this treatment plan. The patient has experienced a series of oral and maxillofacial therapies to treat the congenital disease and extensive surgical intervention to compensate for the bony defects. However, owing to the dysplasia of the edentulous area, especially on the maxilla, it was difficult to find sufficient bone for graft survival. Moreover, the severe vertical bone defect combined with the patient's medium to low smile line suggested that the prosthesis-to-mucosa transition area would not likely be visible with an exaggerated smile. Therefore, an esthetic outcome seemed easier to achieve with an overdenture.

A current attachment system (Novaloc) was selected for this patient; these abutments were used considering the 2 remaining implants which had been placed 15 years earlier, with bone resorption and nonprogressive peri-implantitis. Some rough threads were subgingival, but not in the bone, suggesting an increased likelihood of peri-implantitis progression and bone loss, potentially resulting in implant loss. Accordingly, nonsplinted abutments were selected to enable future replacement of any



**Figure 5.** A, Occlusal view of maxillary overdenture. B, Intraoral view of definitive prostheses. C, Occlusal view of mandibular fixed partial denture.

failing implants without remaking the overdenture and other components such as bars. Three new implants rather than 2 in the maxilla for a total of 5 implants to support the overdenture were preferred to take possible future implant failures into account as the remaining bone was healthy but compromised with regard to its volume. Should an implant fail, the existing overdenture can still be supported on the 4 remaining implants. The rehabilitation of the edentulous maxilla by means of 4

nonsplinted narrow- or standard-diameter implants with an overdenture retained with stud-type attachments has become more common, as the survival is similar to that of splinted implants—even with a U-shaped overdenture.<sup>9-12</sup>

Other considerations in selecting this abutment system (Novaloc) were the unevenly distributed height of implant platforms caused by the major vertical bone defect due to previous implant loss, more subgingivally placed new implants, the amount of existing bone, and the unpredictable nature of bone grafting. Because of the complexity of the surgical stage of the rehabilitation and the mixture of existing and new implants, the leveling of the abutment platforms would likely have been problematic. Straight abutments are available in 6 gingival heights (1 to 6 mm), and 5 heights (2 to 6 mm) are available for 15-degree angled abutments. A prosthetic divergence of up to 60 degrees between 2 abutments can be accommodated with angled abutments.

On the maxillary arch, an open-palate, U-shaped overdenture with individualized pink resin for the gingiva was delivered to the patient. The custom shape and arrangement of the papillae and teeth gave the denture a natural appearance. Light retention (white) inserts (Novaloc) were chosen to enable adequate retention when using 5 abutments. In the mandibular arch, the FPD with pink porcelain gingiva restored the vertical tissue defect, as the gingiva smoothly transitioned from the anterior natural teeth to the posterior area (Fig. 5).

The laboratory processing for this attachment system (Novaloc) followed regular overdenture indirect processing procedures. This system is available for major implant systems. The new coating of the abutment showed consistent in vitro results, and the PEEK matrices may also be more resistant to wear than inserts made from polyethylene.<sup>4</sup> In vitro and in vivo investigations should be conducted to investigate long-term outcomes with this system.

## SUMMARY

The fabrication of a maxillary overdenture supported by 5 nonsplinted current stud-type overdenture attachments enabled adequate function in the maxillary arch, which had large bony defects and divergent implants. This system enables the use of a combination of prefabricated straight and angled overdenture abutments and enabled correction of the discrepancies of both at implant level and due to angulation.

## REFERENCES

1. Sadowsky SJ, Zitzmann NU. Protocols for the maxillary implant overdenture: A systematic review. *Int J Oral Maxillofac Implants* 2016;31:182-91.
2. Shah K, Yilmaz B, McGlumphy E. Fabrication of a mandibular implant-supported overdenture with a new attachment system: A review of current attachment systems. *Int J Prosthodont* 2017;30:245-7.
3. Albrecht D, Ramirez A, Kremer U, Katsoulis J, Merisque-Stern R, Enkling N. Space requirement of a prefabricated bar on two interforaminal implants: a prospective clinical study. *Clin Oral Implants Res* 2015;26:143-8.

4. Yilmaz B, Ozkir E, Johnston WM, McGlumphy E. Dislodgement force analysis of an overdenture attachment system. *J Prosthet Dent* 12 June 2019. doi: 10.1016/j.prosdent.2018.11.009. [Epub ahead of print].
5. Passia N, Ghazal M, Kern M. Long-term retention behavior of resin matrix attachment systems for overdentures. *J Mech Behav Biomed Mater* 2016;57: 88-94.
6. Kim HC, Paek J. Customized Locator abutment fabrication on inclined implants: A clinical report. *J Prosthet Dent* 2018;119:522-5.
7. Esposito M, Pistilli R, Barausse C, Felice P. Three-year results from a randomised controlled trial comparing prostheses supported by 5-mm long implants or by longer implants in augmented bone in posterior atrophic edentulous jaws. *Eur J Oral Implantol* 2014;7:383-95.
8. Misch C. Dental implant prosthetics. 2nd ed. St. Louis: Mosby/Elsevier; 2015. p. 753-828.
9. Wang F, Monje A, Huang W, Zhang Z, Wang G, Wu Y. Maxillary four implant-retained overdentures via Locator attachment: intermediate-term results from a retrospective study. *Clin Implant Dent Relat Res* 2016;18:571-9.
10. Zou D, Wu Y, Huang W, Wang F, Wang S, Zhang Z, et al. A 3-year prospective clinical study of telescopic crown, bar, and locator attachments for removable four implant-supported maxillary overdentures. *Int J Prosthodont* 2013;26:566-73.
11. Zou D, Wu Y, Huang W, Zhang Z, Zhang Z. A 5- to 8-year retrospective study comparing the clinical results of implant-supported telescopic crown versus bar overdentures in patients with edentulous maxillae. *Int J Oral Maxillofac Implants* 2013;28:1322-30.
12. Cordaro L, Torsello F, Mirisola di Torresanto V, Baricevic M. Rehabilitation of an edentulous atrophic maxilla with four unsplinted narrow diameter titanium-zirconium implants supporting an overdenture. *Quintessence Int* 2013;44:37-43.

#### Corresponding author:

Dr Burak Yilmaz  
The Ohio State University College of Dentistry  
305 W 12th Avenue, Columbus, OH 43210  
Email: [Yilmaz.16@osu.edu](mailto:Yilmaz.16@osu.edu)

#### Acknowledgments

The patient provided informed written consent to publish his pictures. All treatment was paid for by the medical insurance of the patient. The authors have no direct or indirect financial relationship with Straumann Institute and did not receive a benefit in kind or cash for the current report. Straumann Institute contributed in part to the open access fee for this article.

Copyright © 2019 by the Editorial Council for *The Journal of Prosthetic Dentistry*.  
<https://doi.org/10.1016/j.prosdent.2019.07.013>